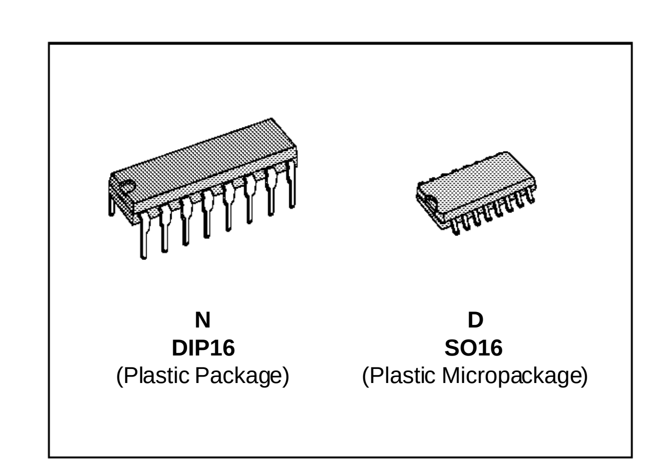


LM146
LM246 - LM346

PROGRAMMABLE QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- PROGRAMMABLE ELECTRICAL CHARACTERISTICS
- BATTERY POWERED OPERATION
- LOW SUPPLY CURRENT (250µA/amplifier)
- GAIN-BANDWIDTH PRODUCT : 1MHz
- LARGE DC VOLTAGE GAIN : 120dB
- LOW NOISE VOLTAGE : $28nV/\sqrt{Hz}$
- WIDE POWER SUPPLY RANGE : ±1.5V to ±22V
- CLASSE AB OUTPUT STAGE. NO CROSS-OVER DISTORTION
- OVERLOAD PROTECTION FOR INPUTS AND OUTPUTS



ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LM146	–55°C, +125°C	•	•
LM246	–40°C, +105°C	•	•
LM346	0°C, +70°C	•	•
Example : LM246N			

146-01.TBL

DESCRIPTION

The LM346 consists of four independent, high gain, internally compensated, low power programmable amplifiers. Two external resistors (R_{set}) allow the user to program the gain-bandwith product, slew rate, supply current, input bias current, input offset current and input noise. For example the user can trade-off supply current for bandwidth or optimize noise figure for a given source resistance. In a similar way other amplifier characteristics can be tailored to the application.

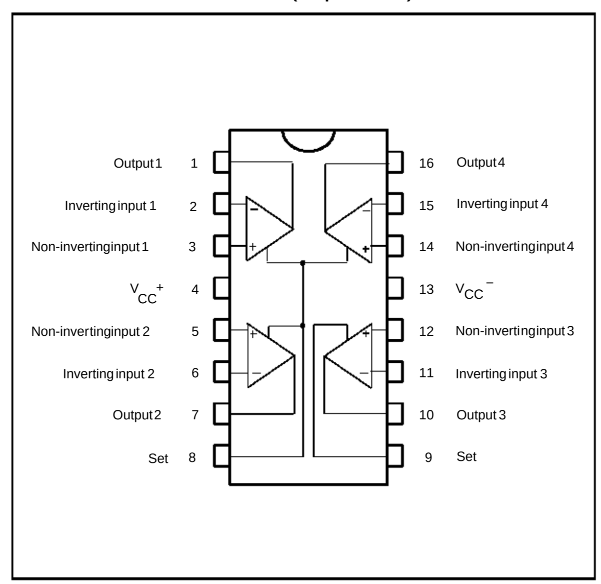
Except for the two programming pins at the end of the package the LM346 pin out is the same as the LM324 and LM348.

PROGRAMMING EQUATIONS :

Total supply current = 1mA (I_{set} = 10µA)
Gain-bandwidth product = 1MHz (I_{set} = 10µA)
Slew rate = 0.5V/µs (I_{set} = 10µA)
Input bias current ≈30 nA (I_{set} = 10µA)
I_{set} = current into pin 8 and pin 9
(see schematic diagram)

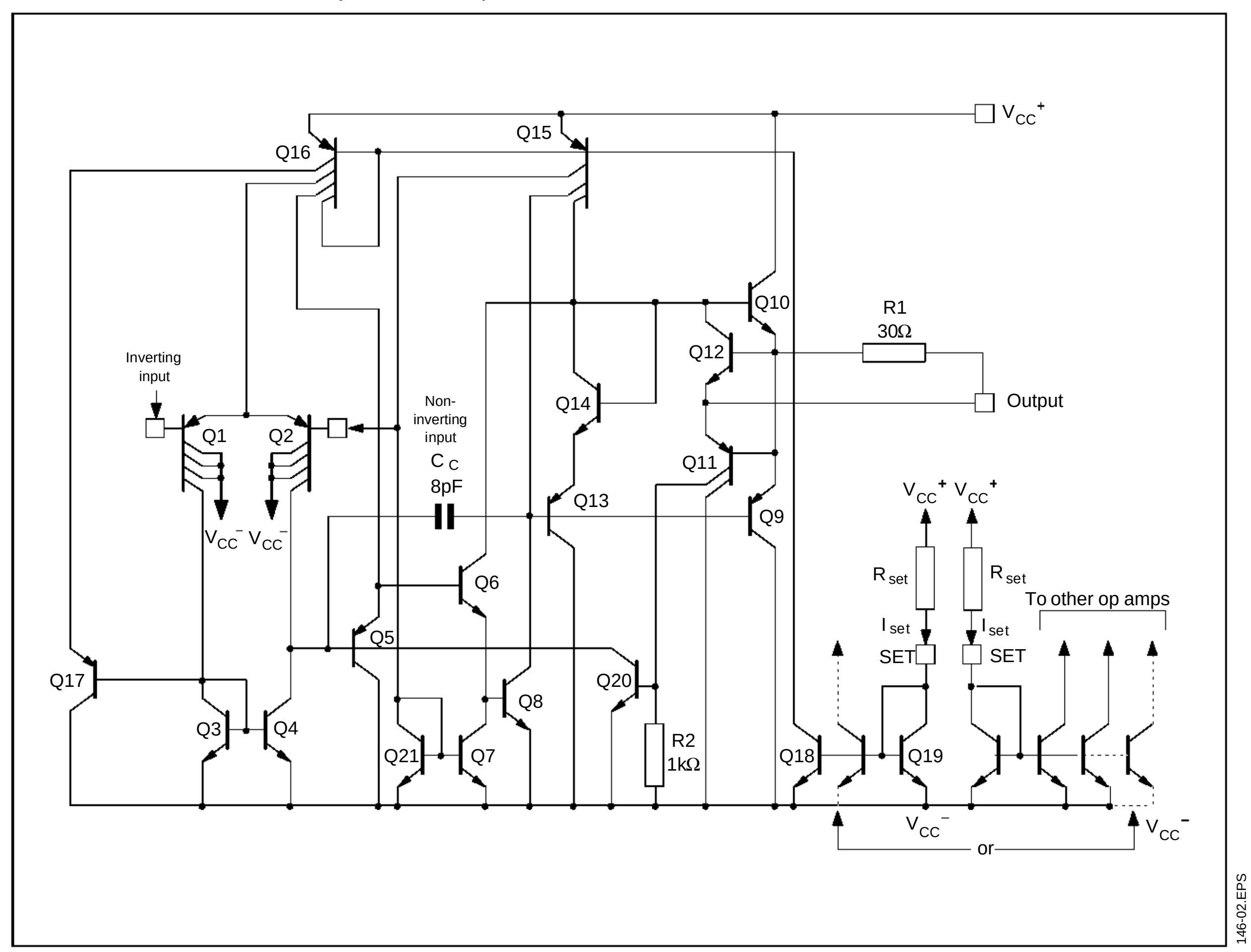
$$I_{set} = \frac{V_{CC}^{+} \pm \; V_{CC}^{\pm} \pm 0.6V}{R_{set}}$$

PIN CONNECTIONS (top view)



146-01.EPS

SCHEMATIC DIAGRAM (1/4 LM146)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM146	LM246	LM346	Unit
V_{CC}	Supply Voltage	±22	±22	±22	V
V_i	Input Voltage - (note 1)	±15	±15	±15	V
V_{id}	Differential Input Voltage	±30	±30	±30	V
	Output Short-circuit Duration - (note 2)	Infinite			
P_{tot}	Power Dissipation N/D Suffix	500			mW
T_{oper}	Operating Free-air Temperature Range	–55 to +125	–40 to +105	0 to +70	°C
T_{stg}	Storage Temperature Range	–65 to +150	–65 to +150	–65 to +150	°C

146-02.TBL

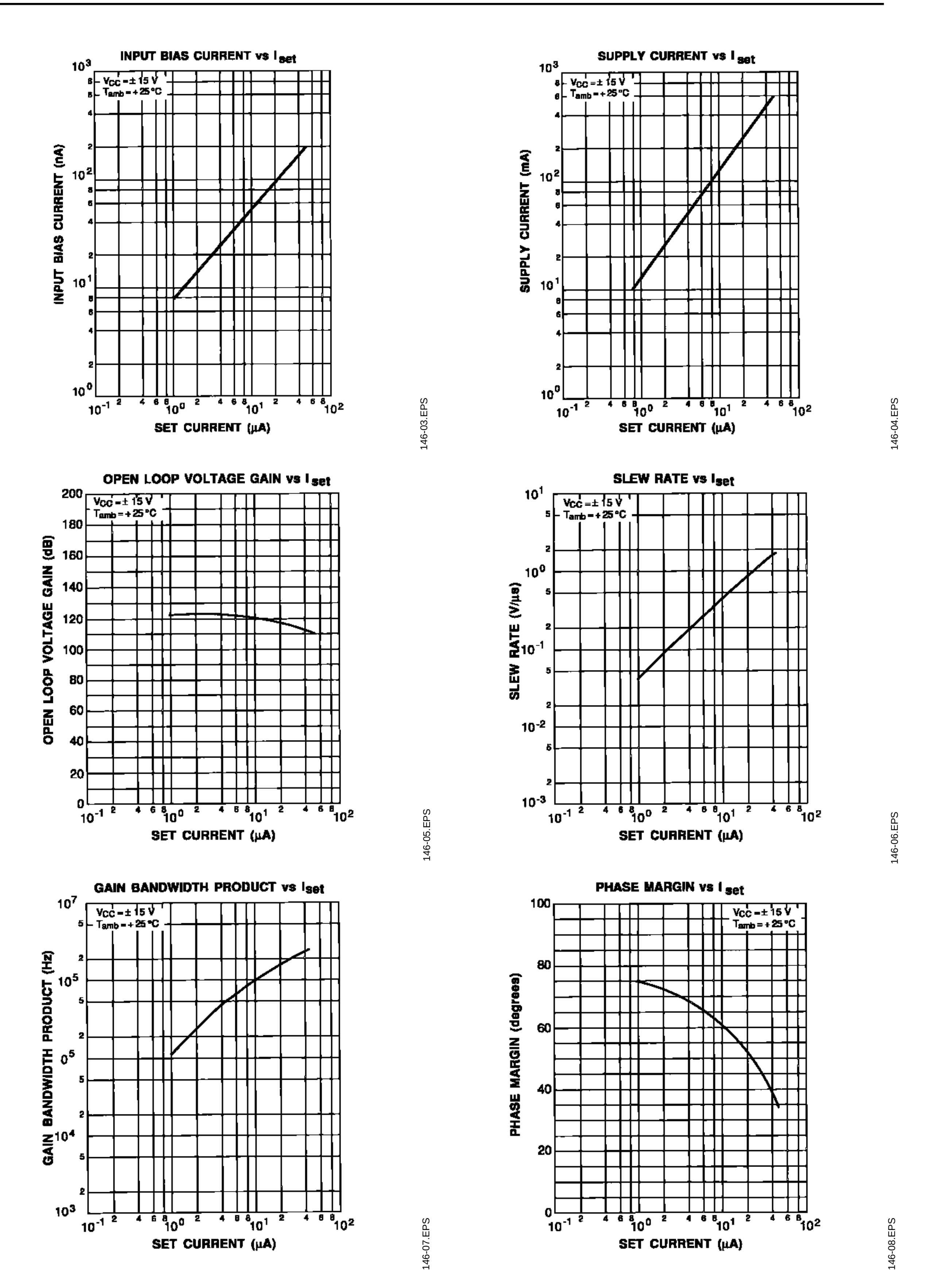
Notes : 1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
2. Any of the amplifier outputs can be shorted to ground indefinitly ; however more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

ELECTRICAL CHARACTERISTICS

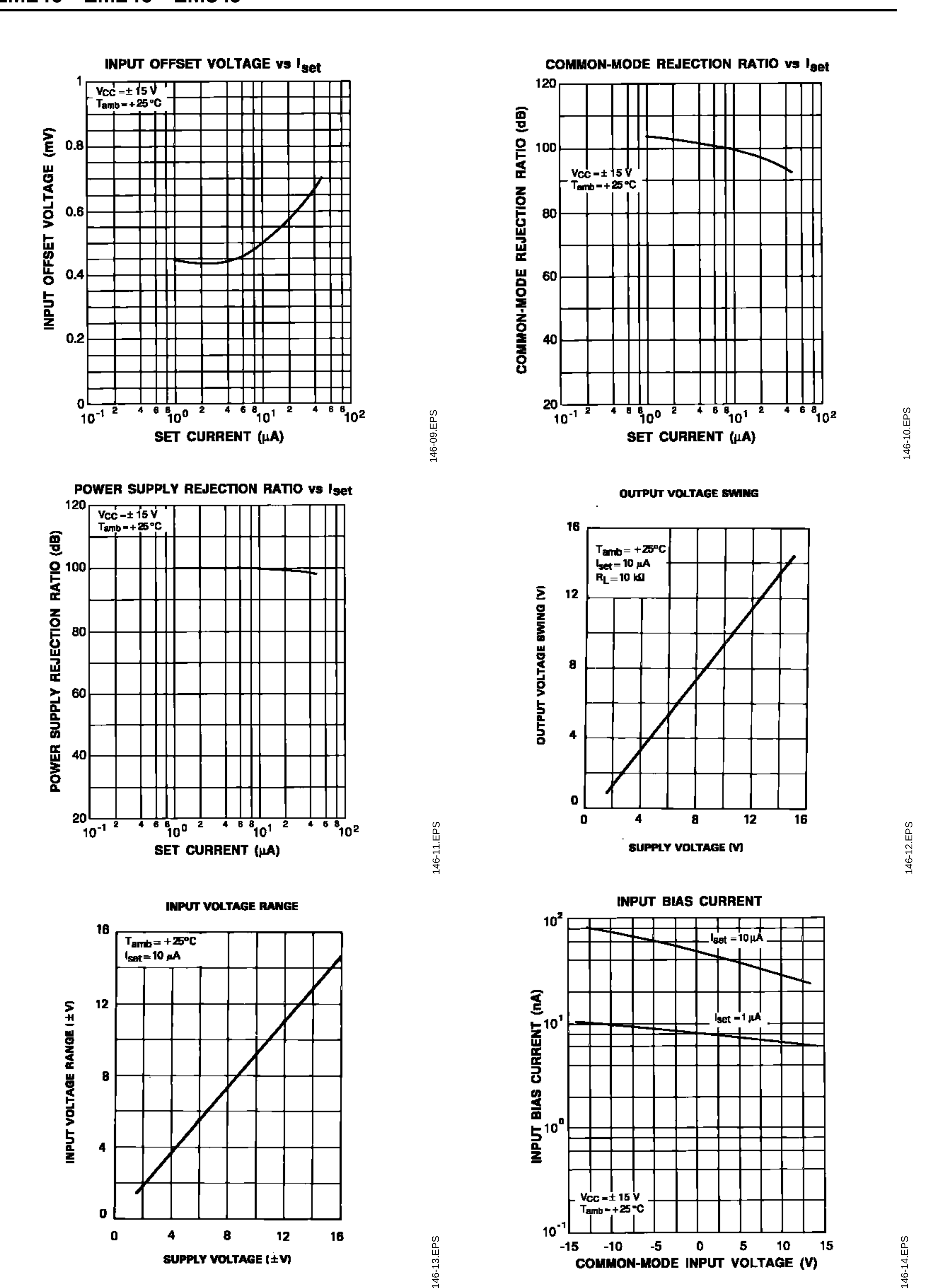
V_{CC} = ±15V, I_{set} = 10µA, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	LM146			LM246 - LM346			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		0.5	3 5		0.5	5 6	mV
I_{io}	Input Offset Current T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		2	20 25		2	100 100	nA
I_{ib}	Input Bias Current T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		30	100 100		30	250 250	nA
A_{vd}	Large Signal Voltage Gain (V_o = ±10V, R_L = 10kΩ) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	100 50	1000		50 25	1000		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	80 80	110		80 80	110		dB
I_{CC}	Supply Current, all Amp, no Load T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		1	2 2		1	2 2	mA
V_{icm}	Input Common Mode Voltage Range T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	±13.5 ±13.5			±13.5 ±13.5			V
CMR	Common Mode Rejection Ratio ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	80 70	110		80 70	110		dB
I_{OS}	Output Short-circuit Current T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	10 4	20	30 35	10 4	20	30 35	mA
± V_{opp}	Output Voltage Swing (R_L = 10kΩ) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	12 12	14		12 12	14		V
SR	Slew Rate (V_I = ±10V, R_L = 10kΩ, C_L = 100pF, T_{amb} = 25°C, unity Gain)	0.3	0.5		0.3	0.5		V/µs
R_I	Input Resistance		1			1		MΩ
C_I	Input Capacitance		2			2		pF
V_{o1}/V_{o2}	Channel Separation (R_L = 10kΩ, V_o = 12V_{pp})		120			120		dB
GBP	Gain Bandwidth Product (V_I = 10 mV, R_L = 10kΩ, C_L = 100pF f = 100kHz, T_{amb} = 25°C)	0.8	1		0.5	1		MHz
THD	Total Harmonic Distortion (f = 1kHz, A_v = 20dB, R_L = 10kΩ C_L = 100pF, T_{amb} = 25°C, v_o = 2V_{pp})		0.015			0.015		%
e_n	Equivalent Input Noise Voltage (f = 1kHz, R_s = 100Ω)		28			28		$\frac{nV}{\sqrt{Hz}}$

146-03.TBL



INPUT BIAS CURRENT vs Iset
VCC = ± 15 V
Tamb = + 25 °C
INPUT BIAS CURRENT (nA)
SET CURRENT (µA)
146-03.EPS
SUPPLY CURRENT vs Iset
VCC = ± 15 V
Tamb = + 25 °C
SUPPLY CURRENT (mA)
SET CURRENT (µA)
146-04.EPS
OPEN LOOP VOLTAGE GAIN vs Iset
VCC = ± 15 V
Tamb = + 25 °C
OPEN LOOP VOLTAGE GAIN (dB)
SET CURRENT (µA)
146-05.EPS
SLEW RATE vs Iset
VCC = ± 15 V
Tamb = + 25 °C
SLEW RATE (V/µs)
SET CURRENT (µA)
146-06.EPS
GAIN BANDWIDTH PRODUCT vs Iset
VCC = ± 15 V
Tamb = + 25 °C
GAIN BANDWIDTH PRODUCT (Hz)
SET CURRENT (µA)
146-07.EPS
PHASE MARGIN vs Iset
VCC = ± 15 V
Tamb = + 25 °C
PHASE MARGIN (degrees)
SET CURRENT (µA)
146-08.EPS


INPUT OFFSET VOLTAGE vs Iset
VCC = ± 15 V
Tamb = + 25 °C
INPUT OFFSET VOLTAGE (mV)
SET CURRENT (µA)
146-09.EPS
COMMON-MODE REJECTION RATIO vs Iset
VCC = ± 15 V
Tamb = + 25 °C
COMMON-MODE REJECTION RATIO (dB)
SET CURRENT (µA)
146-10.EPS
POWER SUPPLY REJECTION RATIO vs Iset
VCC = ± 15 V
Tamb = + 25 °C
POWER SUPPLY REJECTION RATIO (dB)
SET CURRENT (µA)
146-11.EPS
OUTPUT VOLTAGE SWING
Tamb = + 25°C
Iset = 10 µA
RL = 10 kΩ
OUTPUT VOLTAGE SWING (V)
SUPPLY VOLTAGE (V)
146-12.EPS
INPUT VOLTAGE RANGE
Tamb = + 25°C
Iset = 10 µA
INPUT VOLTAGE RANGE (± V)
SUPPLY VOLTAGE (± V)
146-13.EPS
INPUT BIAS CURRENT
Iset = 10 µA
Iset = 1 µA
VCC = ± 15 V
Tamb = + 25 °C
INPUT BIAS CURRENT (nA)
COMMON-MODE INPUT VOLTAGE (V)
146-14.EPS

INPUT BIAS CURRENT vs TEMPERATURE

INPUT BIAS CURRENT (nA): 0, 20, 40, 60, 80, 100

$V_{CC} = \pm 15\ V$

$I_{set} = 10\ \mu A$

$I_{set} = 1\ \mu A$

TEMPERATURE (°C): –75, –35, 5, 45, 85, 125

146-15.EPS

INPUT OFFSET CURRENT vs TEMPERATURE

INPUT OFFSET CURRENT (nA): 0, 2, 4, 6, 8, 10

$V_{CC} = \pm 15\ V$

TEMPERATURE (°C): –75, –35, 5, 45, 85, 125

146-16.EPS

SUPPLY CURRENT vs TEMPERATURE

SUPPLY CURRENT (mA): 10^{-2}, 2, 4, 6, 8, 10 1, 2, 4, 6, 8, 10^{0}, 2, 4, 6, 8, 10^{1}

$V_{CC} = \pm 15\ V$

$I_{set} = 10\ \mu A$

$I_{set} = 1\ \mu A$

TEMPERATURE (°C): –75, –35, 5, 45, 85, 125

146-17.EPS

OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

OPEN LOOP VOLTAGE GAIN (dB): 40, 60, 80, 100, 120, 140

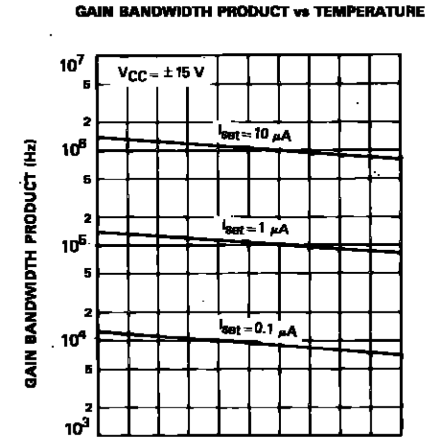
$V_{CC} = \pm 15\ V$

$I_{set} = 1\ \mu A$ to $10\ \mu A$

TEMPERATURE (°C): –75, –35, 5, 45, 85, 125

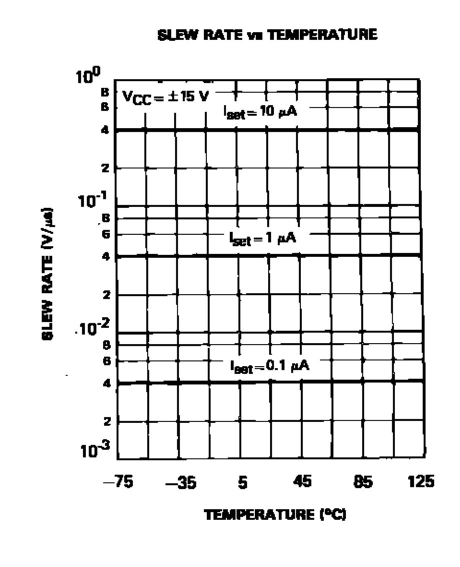
146-18.EPS

GAIN BANDWIDTH PRODUCT vs TEMPERATURE

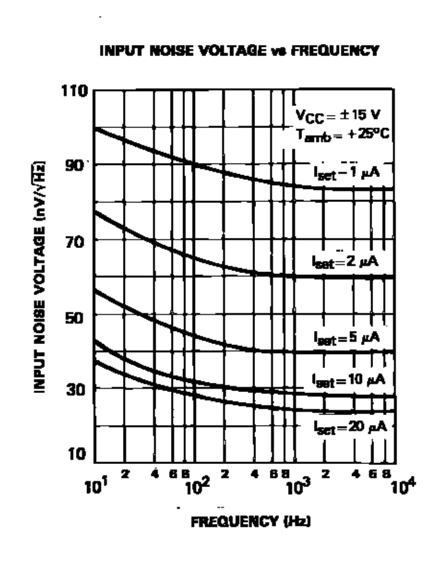


146-19.EPS

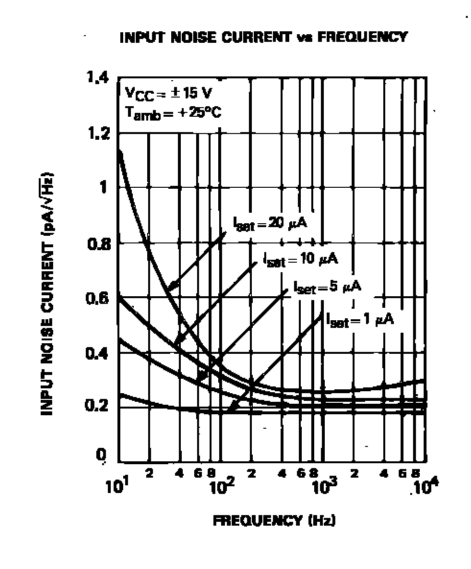
SLEW RATE vs TEMPERATURE



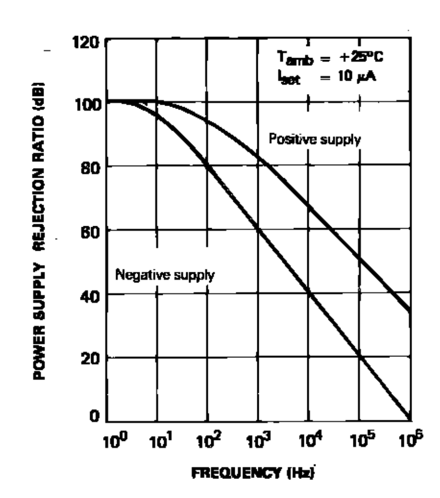
146-20.EPS



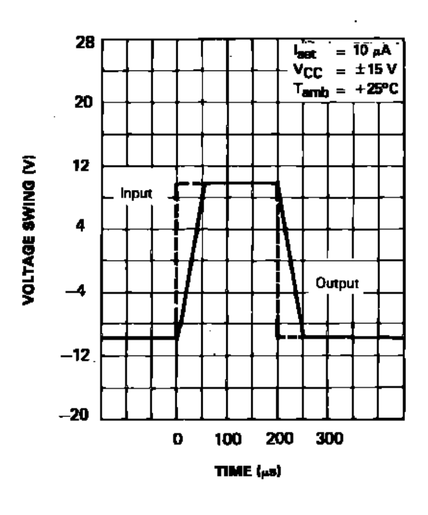
146-21.EPS



146-22.EPS



146-23.EPS



146-24.EPS

OUTPUT (mV): 50, 0, -50

INPUT (mV): 50, 0, -50

I_{set} = 10µA

V_{CC} = ±15V

T_{amb} = +25°C

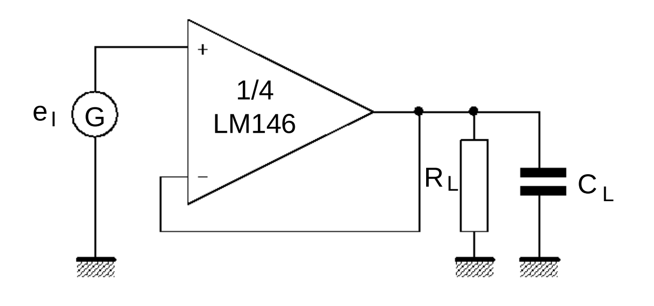
C_L = 100pF

R_L = 10kΩ

0 1 2 3 4 5

TIME (µs)

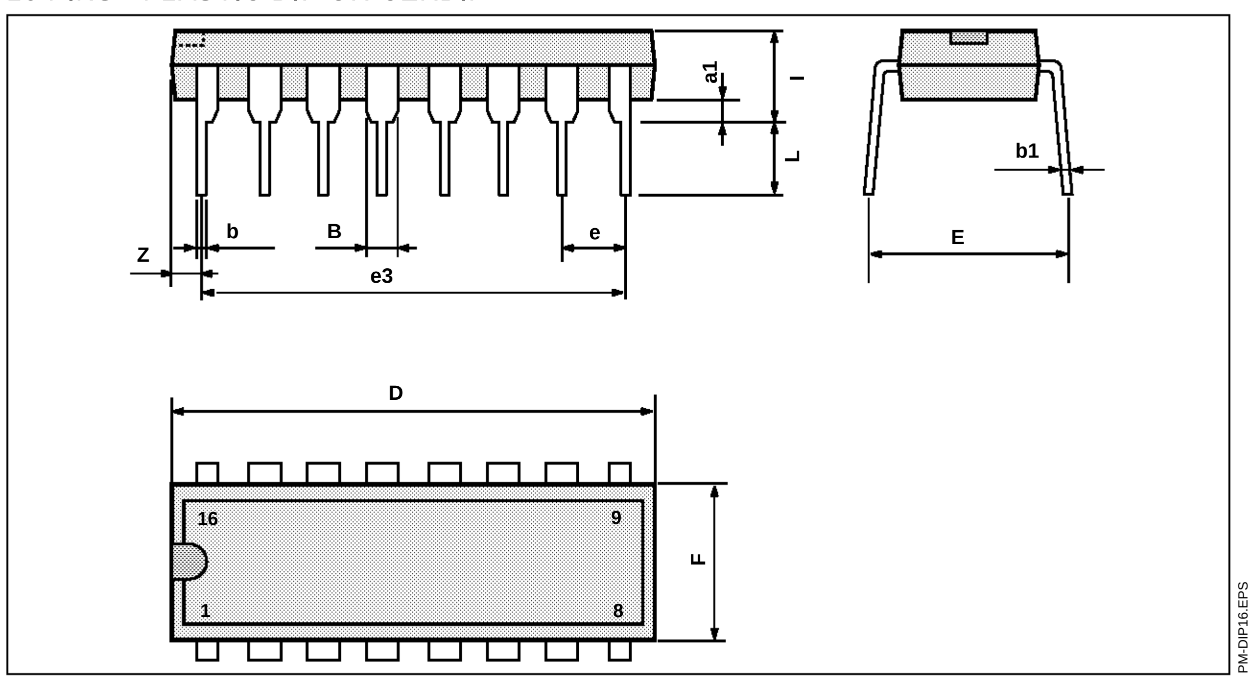
146-25.EPS



146-26.EPS

PACKAGE MECHANICAL DATA

16 PINS - PLASTIC DIP OR CERDIP

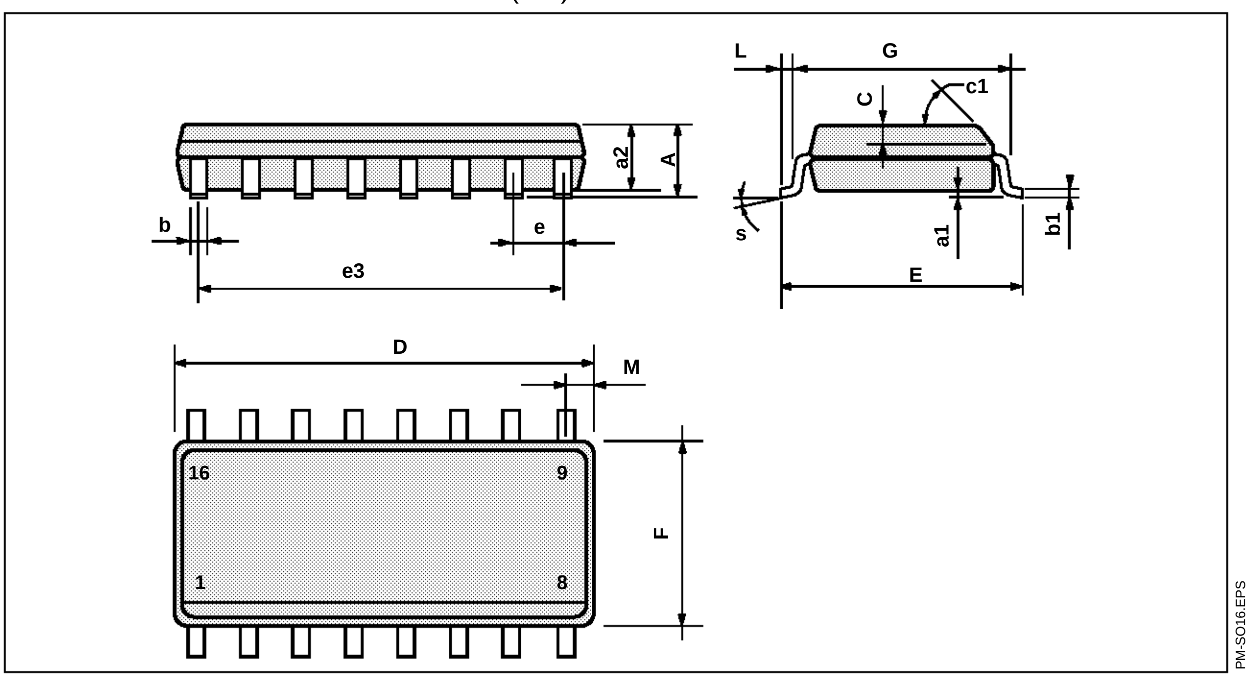


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050

DIP16.TBL

PACKAGE MECHANICAL DATA

16 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45^o (typ.)					
D	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.209

SO16.TBL